A premier (limited information) multi-regional input-output matrix for Argentina 2019*

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Abstract

Multi-regional input-output (MRIO) matrices are an important tool for regional economic analysis, but compiling the data for them remains challenging, especially in developing countries like Argentina. There is no consistent, up-to-date, official national I-O table available for Argentina, and data at the provincial level is limited and fragmented across different sources. This paper develops a premier (limited information) multi-regional input-output matrix for Argentina 2019 making a dual contribution: (i) constructing the first MRIO table for Argentina using official and customized sources, and (ii) evaluating I-O multipliers, providing insights for future applications. The MRIO table includes 5 regions aggregating the 24 Argentinean provinces and 20 economic sectors. While only basic multipliers are presented, the table provides a foundation for more in-depth input-output modeling and analysis of production, consumption, and trade linkages between regions and sectors in Argentina. We found a high concentration in the provinces of the Pampeana region in gross output, value added and regional internal inputs, although less in external inputs, confirming the asymmetric structure of the country. In addition, the analysis of multipliers allows us to detect some relevant links in the peripheral regions reflecting the interaction of spatial location and sector specialization in a federal and heterogeneous open developing economy.

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1 Introduction

The spatial allocation of population, natural resources and economic activity is an extremely relevant aspect for the analysis of local and/or regionally oriented public policies as well as for evaluating the impact of macroeconomic policies. The social and economic structure at regional level is especially relevant and should be taken into account when developing analytical tools aimed at studying the impact of public policies. As Hewings (2014) highlights, macroeconomic policies are *blind*, generating asymmetric economic and social impacts, depending on the particular socioeconomic structure, natural resources, laws and regulations, and other aspects characterizing the regions. These issues are especially relevant in the context of a relatively large, economically and socially heterogeneous, developing country with a federal organization such as Argentina. In fact, several studies have highlighted the relevance of structural differences as mechanisms enhancing asymmetric regional economic dynamics and *resilience* in Argentina. For example, works by Elosegui et al. (2019), Elosegui et al. (2022) and Niembro and Calá (2021), among others, have examined how differences in industrial composition, export profiles, and other structural factors lead to divergent socioeconomic trajectories across regions in Argentina. These structural asymmetries allow some regions to better withstand economic shocks and crises, while other more specialized regions remain vulnerable. Understanding these uneven impacts and resilience capacities across the national territory is crucial for designing effective regional development policies in Argentina. In this sense, having an analytic tool taking into account the sector and regional productive heterogeneity becomes relevant to monitor the direct impact and indirect spillovers of macroeconomic and place based economic policies.

The Multi-Regional Input Output (MRIO) Table have become an extremely relevant tool for regional and macroeconomic policy analysis and are widely used to analyze and simulate the impacts of macroeconomic shocks on both sector and spatial dimensions. The applications include the analysis of impulse response reactions to internal economic policies/sector idiosyncratic shocks and/or external (systemic) shocks within and between the regions. In that sense, the MRIO table is a key input to build more complicated Computational General Equilibrium (CGE) models and/or Social Accounting Matrices (SAM) as well as Dynamic Stochastic and General Equilibrium Models (DSGE) [1]. In particular, our interest is in building a MRIO table as a technical

[1] See for instance the *"Input-Output Dynamic Stochastic General Equilibrium Model"* of the European Union, IO-DSGEM.

tool useful at analyzing and simulating the inter-regional impact of different macroeconomic as well as monetary and financial policies and regulations.

The MRIO matrix calculation both at national and regional level has improved over time due to an increased computation power and several relevant analytical developments. However, the information availability is still an important challenge and an actual constraint, both at developed and developing economies. That is the case of Argentina, where a consistent, current and official national I-O is not available and the information from the regions (provinces) is very limited and usually compiled through various different data sources, surveys and/or official registries. An additional constraint in calculating MRIO tables is the limited or lack of information on inter-regional trade transactions. Therefore, the MRIO table has been constructed under conditions of *limited information*. The last official I-O matrix for Argentina dates to year 1994, but the most recent Supply Use Tables (SUTs) have been updated to year 2020. Therefore, this *premier* MRIO table relies on the I-O matrix table for 2019 calculated by Michelena (2023). In addition, the inter-regional trade information is calculated based on provincial turnover tax information as detailed in Elosegui et al. (2022). Despite, these considerable challenges and limitations, the endeavor is worth it. Indeed, in a large and heterogeneous federal country, with a considerable productive diversity and marked regional development asymmetries, the MRIO table constitutes an extremely useful tool for economic policy analysis.

The aim of this paper is twofold; first (and the main contribution): it describes the construction of (the first for our registries) a MRIO table for Argentina for the year 2019 based on information from several official (and customized) sources. Second, the paper evaluates several I-O multipliers performing a basic review of the empirical value of the MRIO table and presenting some guidance for future applications.

The rest of the paper is organized as follows. Section 2 summarizes the related literature on the inter-regional and/or multi-regional I-O construction as well as the empirical analysis and applications in other economies and previous developments at Argentina. Section 3 introduces the methodology and describes the information sources as well as the main variables included in the analysis. Section 4 introduces an empirical application of the most common multipliers and the estimation results. Finally, in Section 5, we introduce the main conclusions and the next steps of this research agenda.

2 Literature and Inter-regional I-O use in Policy Analysis

The importance of regional information and analysis for regional planning and for measuring the achievement of development programs in developed and developing regions can be traced back to Isard (1960). As mentioned by this author, it has antecedents in Quesnay (1759)´s Tableau. In 1960, Isard's book highlighted the importance of regional analysis, with the premise that a region is, by definition, an open economy and that the national economy is a result of the social and economic interactions between the different regions. Therefore, to fully understand the aggregated national economy is necessary to considering the importance and relevance of the regions and their interactions. The author indicates that *"we should be able to develop in considerable detail and over time its financial and commodity and services relationships"* as a key ingredient of macroeconomic analysis. Also, the *"mutual dependence and link between the several pertinent systems could be study to understand the internal structure of the regions as well as the inter-regional system in its totally."* The latter, can be actually approximated by using a national I-O table, but the understanding of the full internal structure requires not only a sector but also an spatial dimension that can only by approximated by an inter-regional or a multi-regional I-O table.

In addition, Isard (1960) emphasized the relevance of the commodity flows, approximated (back then as it is today) in US by using transport flows. These commercial flows *"provide useful information on the strategic connections of the regions."* The author introduced a discussion of the location quotient, as used back in the 40s by the U.S. National Resources Planning Board using wage earnings (employment data).[2] The combination of vertical data (employment, output, value added) and horizontal data (commercial flows) are considered to be *"essential"* to understand the national economy and its interaction with the rest of the world. The vertical and horizontal information is jointly analyzed in the inter-regional or multi-regional I-O table, showing the interactions between the friction of distance and the attraction of relevant markets in explaining the trade flows, the employment and income levels as well as their social implications. Indeed, the work by Isard (1960) was one of the first in discussing the basic structure of a more detailed inter-regional framework as developed later by Miller (1966). Also, Miller (1969) developed a two-region model aiming at analyzing the actual cost of measuring gross regional output without taking into account inter-regional linkages. The results showed that those linkages actually have an important role in the regions and the overall national economy.

[2]The location quotients based on employment, output and value added date are discussed further below.

In their seminal book, Miller and Blair (2009) analyze the challenges involved in incorporating those important regional features into an input output framework as the one early developed by Isard (1960) and addressing the idea of fully considering the proper interconnections between the regions. In this context, the authors distinguish between the inter-regional IO (*"in one version"*) and the multi-regional models (*"in another version"*). The inter-regional model, would require a *"complete (ideal) set of both intra and inter-regional data"* including both, technical coefficients and inter-regional trade of inputs and outputs. In some sense, aggregated technical coefficients of the national I-O would be a weighted average of the technical coefficients (production functions) of each region. However, the actual detailed information of the production function in each region is not always available. Therefore, the so called inter-regional input–output model requires a large amount of detailed data. For this reason, there have been few real-world applications.[3] and a complete inter-regional model is generally impossible to implement because of data requirements. Instead, a more operational framework is usually based in limited information, mostly relying in (consistent) estimations of the intra and inter-regional transactions as the one required in the IRIO model. This model has come to be known as a Multi-Regional Input–Output (MRIO) model. The MRIO model contains estimated counterparts of the regional technical coefficients matrices and/or the inter-regional input (trade) coefficients matrices. The limited information approximation is an attempt to specifying a model in which the data are more easily obtained using available information and approximations techniques.[4]

Nowadays, the scientific evidence indicates that the MRIO table is an important tool to understand the regional economic structure, resources and factors localisation, productive and social capabilities in analysing the impact of macroeconomic and regional policies as well as, the regional resilience to different external shocks. The MRIO table analysis is particularly relevant in large and regionally heterogeneous countries as well as in federal countries. The tool can provide valuable insights both for national and regional (provincial/state) authorities during the decision making process and/or the evaluation of macroeconomic, financial or regional economic development policies. Despite the fact that the methodology and technology to calculate the MRIO table is available, the main (and usually the only) constraint, especially in developing countries, is the limited statistical information. For instance, the work by Haddad et al. (2017) describes process

[3]For instance, the Japanese inter-regional tables (beginning in 1960) based in a very rich survey source (Akita and Kataoka, 2002).

[4]It should be noted that Miller and Blair (2009) definition contrast with the one developed by Hewings (2014) and it is the same as the one adopted by Vallecillas (2015) for the case of Colombia among others.

of estimating a inter-regional IO under limited information for the Brazilian case using the IIOAS method.[5]

The interesting work by Sargento et al. (2012) emphasize the importance and relevance of the multi regional matrices in the analysis of the relevant spillovers and feedback relationships between regions. In their work, the authors highlight the relevance of the inter-regional trade information in the construction process of the MRIO table. However, they recognize that most of the time, that information is not actually available, and it is *"problematic"* to find for the researchers. The paper analyses the use of indirect inter-regional trade estimates by comparing different inter-regional trade estimation methods and assessing the sensitivity of the different models compared with an actual inter-regional I-O and inter-regional trade data. To build the multi regional matrix, they consider a group of 14 European countries (as the *"regions"*) as well as export and import trade information, more reliable and available than inter-regional data as an actual proxy of the inter-regional trade. The authors compared the actual inter-regional trade information based on the foreign trade statistics with three different non-survey trade estimates: (i) the simple gravity model estimation, where the exports from origin to destination region depends on the size of the regions and the inverse of their spatial distance; (ii) a data pooling structure assuming a simple average of the imports from all the countries (regions) and (iii) a variation of model (i) using a distance decay parameter in the estimation. In all three cases, the authors considered that the observed flows (the export and import actual trade) were unknown. A RAS adjustment was applied to the different models to verify the row and column total sum constraint. Then, the three different estimations are compared with the actual trade data. The gravity model (iii) with the distance decay estimator and RAS adjustment resulted in the closest estimate to the actual inter-regional trade data. Interestingly, the methodology proposed as the closest estimation technique is similar to (simpler than) the one analyzed in the Argentinean provincial case by Elosegui et al. (2022). The authors conclude that the use of different inter-regional trade estimation techniques seems not to affect the actual input-output model and conclude that for the case under analysis, do not reject the reasonability of using indirect estimates for inter-regional trade for those cases in which survey or census-based information is not available. In addition, the authors used a simulation exercise to compare the estimates by computing the impact of a final demand change on sector output vectors reaching a similar conclusion. To be cautious with the results, the authors underscored

[5]Despite being based in limited information, the Inter-regional table is latter used by Sanguinet et al. (2021) to successfully analyze the short term impact of Covid-19 on the sub-national supply chains at Brazil

that the regions within a country are usually more open than the European countries considered in their analysis.

In the present analysis, Michelena (2023) Argentinean I-O matrix is used together with the inter-provincial trade information from Elosegui et al. (2022) as well as geographical value added calculated by ECLAC García Díaz et al. (2023) to calculate a MRIO for Argentina. The table aggregates the 24 provinces in 5 regions (see Figure A of Appendix) and considers twenty economic sectors. The next section describes the information and the methodology used to calculate the MRIO for Argentina.

3 Information and Methodology

3.1 Inter-regional asymmetries and economic information

As described by Elosegui et al. (2022) Argentina is a federal country that is characterized by a strong asymmetry in the economic development of its 24 provinces that here are aggregated in 5 regions (South, Pampeana, Cuyo, Northeast and Northwest) [6]. In fact, the Pampeana region explains 71% of national value added concentrating 65% of the population (García Díaz et al., 2023). In contrast, the Northeast region with 9% of the population holds 5% of the value added indicating that the asymmetries between the provinces and regions are quite noticeable. This long-standing situation has been analyzed by prestigious scholars, like Bunge (1940), who described the regions as a *"folding fan"*, with the head in Buenos Aires Port (the main center) from which the socioeconomic indicators decreased with distance (see Asiain, 2014). Since the national organization, with the Constitution of 1853 and 1860, fiscal federalism went through several stages until reaching the current co-participation scheme aimed at reducing the referred asymmetries (Porto, 2018). As emphasized by Porto (2018) and Porto and Elizagaray (2011), the co-participation scheme generated a relative convergence of different social indicators. However, after many years the asymmetries remain, and the relative increase in co-participation transfers in favor of lagged regions is not reflected in their relative development. The center Pampeana region still holds a dominant position in socio-economic indicators as shown in the remarkable difference with the rest of the regions.

[6]See Map in the Appendix

3.1.1 Provincial Geographical Gross Value Added Information

The information on the geographical Gross Value Added (GVA) of the different economic sectors of Argentina comes from the ECLAC and the Ministry of Finance (García Díaz et al., 2023). The work updates the estimation of the provincial geographic value added for the period 2004-2021, with a two digits National Classification of Economic Activities (in Spanish, CLaNAE 04) breakdown including 52 sectors. The estimated GVAs are consistent with value added aggregated estimations from the official national accounts. The provincial distribution is also compatible with the original provincial breakdown by National Institute of Statistics and Censuses (INDEC, in Spanish initials), only available for the base year 2004.[7]

In their analysis of the provincial series, García Díaz et al. (2023) analyze the evolution of the provincial value added from 2004 through 2019 concluding that the *economic asymmetries continue to be very relevant in Argentina, although in the period under analysis there was a slight narrowing of the value added gaps*. The observed convergence among the provinces is not actually significant and *if maintained, would not imply a significant modifications [of the actual asymmetries] in the near future.* As noted by the authors, the provinces in the center of the country (Pampeana region) concentrate almost 80% of the economic activity (value added) during all the considered periods *a proportion that has fallen by approximate less than 3.9 percentage points since 2000*. In our analysis, the GVA provincial information is aggregated in 5 regions and 20 sectors and calculated at 2019 prices. Then, the information is used as a key input in the MRIO calculation as we describe below.

3.1.2 Inter-provincial goods and services trade information

The important economic asymmetries are not only measured by comparing synthetic indicators such as the value added by economic sectors. A complementary information to understanding the profound social-economic differences between the provinces arises from the internal trade values. In Elosegui et al. (2022), the authors use an inter-provincial trade database and empirically apply a gravity model to analyze trade for all the Argentinean provinces during year 2017. The paper considers the asymmetric economic structure of the economy, highly concentrated in the Autonomous City of Buenos Aires (CABA, from its Spanish initials) and the Buenos Aires

[7] The provincial GVAs may differ to those calculated by the provincial statistical offices. As usual, it may be some sectors that are statistically significant at provincial level but not captured at national level and not included in the national value added estimations. In their work, the geographical value added for all the sectors where updated by using different official sector statistical series at provincial level and any difference with the aggregated national VA was compiled in a residual (non-distributed) sector.

province.[8] In their empirical analysis, the authors not only quantify the degree of economic and trade interrelation between the regions (by using the inter-provincial trade database) but also introduce some control variables for the main determinants, including structural, economic, and financial variables using different statistical sources. As mentioned before, the aim of the present work is to supplement the research agenda with an structural model, the MRIO matrix, that would give economic cohesion to this vertical and horizontal regional economic information.

As described by Elosegui et al. (2022), the data set used to analyze the inter-regional trade is unpublished and calculated from tax records. The original data comes from the *Arbitration Commission of the Multilateral Agreement on Gross Income Tax (in Spanish, IIBB)*. The information, based on the provincial turnover sales tax, was processed, as reflected in Colina (2019) and Elosegui and Pinto (2018), to calculate trade of goods and services between the 24 provinces of Argentina for the year 2017 and 2021. It should be noted that the tax information is reflecting formal transactions.[9]

3.1.3 National 2019 I-O matrix

The basic information for the MRIO calculation is the national I-O matrix calculated by Michelena (2023). The national matrix includes 107 sectors calculated at 2019 current prices and is based in the 1997 INDEC's official matrix. The I-O matrix was updated through a rearrangement of the recently available Supply and Use Tables (SUTs) published by INDEC and officially updated to 2019 (see Supply and Use Table INDEC, 2022). In recent years, INDEC reviewed the 2018−2020 quarterly national accounts and published updated SUTs. This general framework provided the basic coherence to the demand and supply quarterly accounts estimations. For the year 2019, the SUTs presents 107 activities and 224 products, somewhat smaller than the previous official version from 2004, that included a total of 168 activities and 272 products. In order to calculate the square I-O matrix from the SUTs, the author followed the usual guidelines outlined in EUROSTAT (2008). It is relevant to underscore that all the elements necessary for the I-O construction are available in the SUTs published by the INDEC, with the exception of the import matrix. This key information was

[8] Part of the Pampeana region in this present work.

[9] Most of these declared sales come from the automatic retention schemes operating through the formal financial channels. It should also be noted that provinces have incentives to cross audit and control tax evasion, trying to reduce the under reporting and potential fiscal base hoarding arising from non uniform fiscal treatments (Arias, 2011). Nonetheless, there have been substantial progress lately to harmonize the scope of the tax which is auspicious for future processing of this database.

approximated by using a previous import matrix originally published by INDEC in 2004.[10] The information was updated and complemented with foreign trade data from WITS/COMTRADE database (see World Integrated Trade Solution Website) and adjusted by using a RAS method McDougall (1999). Finally, the data was aggregated to 107 sectors and the final demand import vectors were also calculated (see Michelena, 2023, pages 13-14). The estimated I-O table at current 2019 prices with 19 aggregated sectors is shown in Michelena (2023, page 15) and results the main input for the present MRIO calculation as described in the next section.

3.2 Inter-regional matrix methodology

The regional matrix calculation is somewhat complex and, as mentioned above, generally faces limitations in the necessary information. In practice, there are two basic methodologies for their construction. The direct technique requires specific surveys that are used to estimate statistically robust regional coefficients. However, the surveys generally requires large amounts of economic resources and time, and are not available in most of the countries. Alternatively, the so-called indirect methods calculate adjusted regional coefficients from a national I-O matrix. In this methodology, the regional coefficients are approximated using the available (usually limited) information reflecting the economic structure of the regions.

First, as indicated in the previous section, the MRIO matrix is based on the Argentinean I-O table calculated by Michelena (2023). The initial necessary step is to aggregate the two main information sources, the national I-O and the Geographical Value Added information to 20 sectors based on the ISIC classification (for details, see ISIC Classification Website). The economic sectors where aggregated at a letter level for the majority of the activities sustaining an adequate detail on the main industrial activities.

Second, the provincial based information was aggregated at the 5 regions level by using the ECLAC geographical value added information at 2019 current prices. Those 5 regions are used to allocate the aggregated national I-O information at a regional level.

Third, in order to partitioning the national I-O sectors is necessary to account for their inter and intra-regional transactions. The estimated inter-provincial goods and services trade information is aggregated at the 5 regions level. As we can not rely in any survey or census data, the inter and intra-regional coefficients are approximated by using the location coefficients based on limited

[10] The matrix is not longer available, as was later eliminated during the review of the national accounts for the year 2016.

information, an updated version of the information used and explained at Elosegui et al. (2022). The national I-O transaction matrix is transformed into an input coefficient matrix, the $A = [a_{ij}]$. The next step is finding an appropriate location coefficient to allocate every sector activity in each of the regions. The localization coefficient, LQ, should be estimated so that, the basic national input-output coefficient can be transformed in a regional input output coefficient:

$$c_{ij} = LQ_{ij} \times a_{ij}. \tag{1}$$

The c_{ij} represents the regional input-output coefficient partition of the industry i at the j sector. The LQ_{ij} is the localization coefficient for the industry i at the region j, and a_{ij} is the national (from national I-O matrix) technical coefficient (share) of the industry at the national level.

In order to estimate the location coefficients, different sources of national and regional information can be used. In fact, different authors use regional employment,[11] gross regional output or regional value added among others. In our case, the regional value added is used as shown in the following formulas.[12]

The simple location coefficient (SLQ) measures the specific industry i share within the region $r \in R$ (where R is the set of regions), compared with the share of the same industry in the national economy T, considering an activity level variable X, usually involving either employment, value added or gross output:[13]

$$SLQ_i = \frac{X_{i,r}}{\sum_i X_{i,r}} \bigg/ \frac{X_{i,T}}{\sum_i X_{i,T}}, \tag{2}$$

where $X_{i,r}$ corresponds to the value added from the sector i at the region r and $X_{i,T}$ refers to the sector i value added at the national level.

A $SLQ > 1$ indicates that the proportion of sector i in the region r is above its national share showing that the sector (in an aggregate level) is potentially self-sufficient in the region. On the contrary, a $SLQ < 1$ implies a sector's share at the region that is lower than the sector's share at the national level reflecting a potentially insufficient supply at the local region. Therefore, the region is assumed to be a net importer at that particular sector.

[11] For an application in Argentina see Brondino et al. (2024).

[12] The formulas are valid for any of the other mentioned variables.

[13] As suggested by Flegg and Webber (2000), the employment based coefficients can be affected by the inter-regional productivity changes. Therefore, the authors recommend using either gross output or value added.

The use of the SLQ coefficient has been questioned due to limitations that may arise a the time of estimating the regional production. The SLQ coefficient only considers the inter-regional transactions based on the relative importance of the aggregate sector at the national level. In occasions, national output can be over-estimated for some industries generating a false estimation of the self sufficient threshold of the given industry. To reduce this potential bias other methodologies have been proposed to calculate the location coefficients.

Similarly, and following Flegg and Webber (2000), we define the *Cross-Industry Location Quotient* ($CILQ$) coefficient based on regional information of the respective sectors, i, j of each region r:

$$CILQ_{i,j} = SLQ_{i,r} \Big/ SLQ_{j,r} = \frac{X_{i,r}/X_{i,T}}{X_{j,r}/X_{j,T}}. \tag{3}$$

As suggested by Flegg and Webber (2000), the $CILQ$ coefficients are calculated based on regional value added information.[14] As usual, whenever $CILQ_{i,j} > 1$, the input requirements for sector i at the region r may be satisfied within the region. In the other case, if $CILQ_{i,j} < 1$, the sector i at the region r may require imported inputs from other regions in order to generate its own regional output.

As indicated by Flegg and Webber (2000), several formulas have been proposed to solve some of the potential bias from the $CILQs$ based location coefficients. For instance, the FLQ_{ij} is the *Flegg Location Quotient* for the industry i at the region region j:[15]

$$FLQ_{ij} = \begin{cases} CILQ_{ij} \times \lambda^* & \text{if} \quad i \neq j, \\ \\ SLQ_{ij} \times \lambda^* & \text{if} \quad i = j, \end{cases}$$

where $CILQ_{ij}$ corresponds to the *Cross-Industry Location Quotient*, and $\lambda^* = [log_2(1 + \frac{VAB_r}{VAB_T})]^\delta$ is an adjustment factor weighting the relative size of the region using a $0 \leq \delta < 1$ coefficient. Alternatively, the *Augmented Flegg Location Quotient* for the industry i and purchasing sector j, $AFLQ_{ij}$, is proposed:

[14] It should be noted, that this method is also subject to critics as empirical evidence shows that the $CILQ$ coefficients may still under estimate the inter-regional trade. In fact, Flegg et al. (2016) analyze the I-O goodness of fit of different location coefficients.

[15] See González et al. (2022) for an online and desk version open access software tool to estimate regional matrices using the *App-RegMIP* applying these regional coefficients estimations (FLQ, AFLQ) with a particular application to Buenos Aires province at Argentina.

$$AFLQ_{ij} = CILQ_{ij} \times \lambda^* \times \log_2(1 + SLQ_j). \quad (4)$$

Again, the $CILQ_{ij}$ is the *Cross-Industry Location Quotient* and the SLQ_j is the *Simple Location Quotient* for the sector j. Whereas $\log(1 + SLQ_j)$ is a logarithmic adjustment factor for the size of the region λ^*.

In our case, we use the FLQ formula with value added sector and regional information. While AFLQ has theoretical advantages over FLQ, their actual empirical performance is quite similar according to various studies (Flegg and Tohmo, 2018). Due to this lack of a significant improvement in accuracy despite AFLQ's greater complexity, it won't be further considered. After selecting the proper location coefficients, the next step involves transforming the regional transaction matrix in an MRIO matrix using the following formula for the input coefficients corresponding to each sector and region:

$$c_{i,j}^{r,r} = \begin{cases} a_{i,j} \times FLQ_{i,j} & \text{if} \quad FLQ_{i,j} < 1, \\ \\ a_{i,j} & \text{if} \quad FLQ_{i,j} \geq 1. \end{cases}$$

In the case of the inter-regional flows, the estimation is not so straightforward and demand a top-down strategy to be completed. Firstly, the total inter-regional flow for each region, it means without considering the trading partner, is estimated using the residual from the last equation, such that:

$$c_{i,j}^{T,r} = \begin{cases} a_{i,j} \times (1 - FLQ_{i,j}) & \text{if} \quad FLQ_{i,j} < 1, \\ \\ 0 & \text{if} \quad FLQ_{i,j} \geq 1. \end{cases}$$

The second step consist in the split of every coefficient $c_{i,j}^{T,r}$ for each region r and each trading partner S (defined as the total number of regions R without the region r), considered in the matrix. In the literature, this estimation is usually carried out by using survey data and or transport data and/or in the case of having limited information using estimations through gravity econometric models (Miller and Blair, 2009). As previously addressed, this work employ a novelty dataset of provincial trade information to carry out such inter-regional trade coefficients approximation. The inter-provincial trade data allows us to estimate, for each productive activity contained in the matrix, a parameter $\theta^{S,r}$, equals to the imports that the region r performs from each trading partner, such that $\sum_r \theta^{S,r} = 1$. Then, the final estimation for the inter-regional coefficients are given by:

$$c_{i,j}^{S,r} = \theta^{S,r} \times c_{i,j}^{T,r}. \tag{5}$$

An additional step is needed in order to have a final consistent MRIO. Indeed, it is necessary to constrain the data so that the ratio of Final Demand to total output result equal to the national matrix aggregated value. This condition is relevant in order to assure that the sum of the intermediate flows in the regional matrix equals the sum of the same flows in the national matrix. Nevertheless, this adjustment creates a difference between the sum of columns, on the one hand, and the sum of the rows, on the other. This inequality is solved using the RAS biproportional method to perform the MRIO matrix adjustment.

The Table 1 below summarizes the MRIO table format for the case under analysis. The square matrix list in columns and rows each of the five regions, including *Cuyo*, *Northeast*, *Northwest*, *Pampeana* and *South*. As usual, the columns indicate the intermediate demand from each sector corresponding to every regions. The rows indicate the demand from each region, including intermediate and final demand.

Table 1: Multi-regional I-O Table for Argentina - 5 regions and 20 economic sectors

	Intermediate Demand					Final Demand	Total Output
	Cuyo (1)	Northeast (2)	Northwest (3)	Pampeana (4)	South (5)		
Cuyo (1)	$Z_{i,j}^{1,1}$	$Z_{i,j}^{1,2}$	$Z_{i,j}^{1,3}$	$Z_{i,j}^{1,4}$	$Z_{i,j}^{1,5}$	F_i^1	Y_i^1
Northeast (2)	$Z_{i,j}^{2,1}$	$Z_{i,j}^{2,2}$	$Z_{i,j}^{2,3}$	$Z_{i,j}^{2,4}$	$Z_{i,j}^{2,5}$	F_i^2	Y_i^2
Northwest (3)	$Z_{i,j}^{3,1}$	$Z_{i,j}^{3,2}$	$Z_{i,j}^{3,3}$	$Z_{i,j}^{3,4}$	$Z_{i,j}^{3,5}$	F_i^3	Y_i^3
Pampeana (4)	$Z_{i,j}^{4,1}$	$Z_{i,j}^{4,2}$	$Z_{i,j}^{4,3}$	$Z_{i,j}^{4,4}$	$Z_{i,j}^{4,5}$	F_i^4	Y_i^4
South (5)	$Z_{i,j}^{5,1}$	$Z_{i,j}^{5,2}$	$Z_{i,j}^{5,3}$	$Z_{i,j}^{5,4}$	$Z_{i,j}^{5,5}$	F_i^5	Y_i^5
Total Inputs	Z_i^1	Z_i^2	Z_i^3	Z_i^4	Z_i^5		
Tax, imp, marg	T_i^1	T_i^2	T_i^3	T_i^4	T_i^5		
Value Added (VA)	X_i^1	X_i^2	X_i^3	X_i^4	X_i^5		
Total Output	Y_i^1	Y_i^2	Y_i^3	Y_i^4	Y_i^5		

The colored matrices indicate to the intra-regional exchanges corresponding to the within sector transactions for every region and economic sector. In the same column the following matrices indicate all the input transactions from the different sectors at the origin region purchased by the sectors belonging to other (destination) regions. In turn, the column matrices represent for each region the sector inputs exported (sold) to other regions (in the rows) indicating all the sector´s activities supplied by the row regions and demanded within the column region. The off-diagonal row matrices indicate the intermediary inputs supplied (sold) from sectors at row region to the destination region and sector at the column. Finally, the final demand matrix includes all the final demand for the sectors at the corresponding row region.

The $Z_{i,j}^{r,n}$ corresponds to the input matrix with $i = 1$ to 20 and $j = 1$ to 20 sectors of $r = 1$ to 5 and $n = 1$ to 5 regions. The $Z_{i,j}^{r,n}$ for $r = n$ are the intra-regional inputs flows whereas $r \neq n$ indicates inter-regional inputs flows. The Z_i vectors corresponds to the total inputs for each input in a given region. The same is true for tax, imports and margins T_i, total value added X_i and total output Y_i. Whereas, F_i^s include final (domestic and foreign) demand.

3.3 Dataset

The information from the MRIO matrix allows us to account for the regional asymmetries that, as mentioned in the introduction, characterize the Argentinean economy. The asymmetries are observed both between regions and economic sectors. The analysis of the multipliers calculated from the matrix reflects these asymmetries, as developed in section 4 and highlights the relevance of the MRIO matrix to analyze economic policies. Indeed, as indicated by Hewings (2014) the macroeconomic policies and external shocks are *"blinded"* or regionally homogeneous but their impacts are influenced by the economic structure of the regions, including the industry mix, financial deepness, the availability of natural resources, social and economic infrastructure among other factors. In the case of Argentina, the work by Elosegui et al. (2019) shows that economic activity at regional and provincial level asymmetrically respond to domestic monetary policy shocks, as given by a change in the interest rate. Using Bayesian methods, the authors show the relevance of basic structural regional differences in explaining the asymmetric effects of the monetary policy shock on different provinces.

Table 2: Social and economic regional comparison

Region	Valued Added	%	Gross Output	%	Total Input	%	Pop.	%	Trade %
Northwest	1,446,626	8	2,717,850	8	1,095,364	8	5,742	13	5
Northeast	876,469	5	1,608,123	5	630,253	4	4,232	9	3
Cuyo	1,088,579	6	2,262,633	6	1,009,399	7	3,314	7	4
Pampeana	12,924,809	71	25,449,199	72	10,337,095	73	29,910	65	83
South	1,741,837	10	3,104,166	9	1,157,052	8	2,611	6	5
Total	18,078,323		35,141,971		14,229,164		45,809		

Source: Author's estimations based on INDEC.

Notes: VA, GO and Inputs are expressed in LCU thousand millions whereas Population is expressed in millions.

As can be seen in Table 2, the Pampeana region is the most important region in the country, concentrating 65% of the total population and more than 70% of the economic activity, measured by value added (71%), gross output (72%) and total inputs (73%). The region is the main economic market concentrating with the 83% of the total inter-regional trade (the only region with trade participation above value added). In contrast, the Cuyo region concentrates the 7% of the population with a slightly lower percentage participation in the activity level and only 4% of the inter-regional trade. In fact, the rest of the regions also present less harmony between population and economic activity participation. On the one hand, the Northern regions have a share of population above their economic activity participation. The Northeast region includes the less developed provinces in the country, explaining less than 5% of the economic activity with 9% of the total population and only 3% of the inter-regional trade. Also, the provinces of the Northwest region represent 13% of the population, with less than 8% of value added, gross output and total inputs and only 5% of the inter-regional trade. In contrast, the South region with the lowest population density, has a population share of 6% similar to the inter-regional trade participation of 5% and below the activity indicators shares, that are 10% for value added, 9% for gross output and 8% for total inputs. In sum, the activity indicators and population shares give an idea of the asymmetries between the grouped regions, that are in some cases related to differences in the sector shares as can be seen in the analysis of Table 3.

Table 3: Regional participation of input trade

Region	Total Input	%	Input (int.)	%	% (int)	Input (ext.)	%	% (ext)
Northwest	1,095,364	8	707,619	6	65	387,745	15	35
Northeast	630,253	6	398,301	3	63	231,952	9	37
Cuyo	1,009,399	7	588,533	5	58	420,866	16	42
Pampeana	10,337,095	73	9,227,597	79	89	1,109,498	42	11
South	1,157,052	8	694,459	6	60	462,594	18	40
Total	14,229,164	100	11,616,509	100	82	2,612,656	100	18

Source: Author's estimations.

Notes: Inputs are expressed in LCU thousand millions.

As Table 3 indicates, the inter-regional input trade between the regions represents 18% of the total input trade. All the regions are more open than the main Pampeana region that holds 42% of the total external inputs traded between the regions representing 11% of the total input trade of the region. The rest of the regions hold 58% of the total external inputs trade, representing more than 35% (as in the case of Northwest) of their total inputs. Indeed, Cuyo with 42% and South with 40% are the regions with more external inputs. The same is true for the Northeast region, with just 9% of the total external input trade explaining 37% of its total inputs. In fact, the main region, Pampeana, holds an internal trade representing 79% of the total inputs trade in the country. In contrast, the internal trade for the Northeast region represents only 3% of the total trade.

As analyzed in Elosegui et al. (2019) the economic policy transmission mechanism across the region are largely influenced by their social and economic structure including the sector and industrial mix. Also, those regional differences can generate different aggregated dynamics that are important to be considered when analyzed economic policies. Table 4 summarizes the regional shares by aggregated economic sectors. It can be seen that the inputs external to the region are quite uniform for the Public adm, educ. and health sector, with the NW region providing 27% of the total external inputs. In contrast, the main provider of Trade & transport external input is the Pampeana region with 31.7%. The Pampeana region, the main region, also dominates the external input provision in Industry (59.7%) and services (Financial, Public utilities and Other services). The South region dominates the Construction and Mining & Energy sectors. In addition, the NW region is a key external input provider for the Primary sector. In the case of the internal inputs, the Pampeana region dominates most of the economic sectors with the exception of the Mining & Energy sector that is dominated by the South region with an important participation of the Cuyo region. The NW region has an important share in Public Admin, Health & Education as well as in Primary Sectors. Those shares are replicated in the case of the Value Added and Gross Output. The highest participation of the poorest NE region is in Public Admin, Health & Education.

Table 4: Regional participation by economic sectors (in percentage)

		Public Adm.	Trade & Transp.	Const.	Ind.	Min. & Energ.	Other Serv.	Prim.	Finan. Serv.	Public Util.
Input Ext.	Cuyo	13.7	11.9	15.7	24.0	11.8	6.8	5.7	8.0	4.6
	NE	18.4	15.3	13.8	3.3	0.2	8.8	17.1	8.0	16.6
	NW	27.4	23.9	16.4	8.0	4.4	6.9	38.4	11.2	11.9
	Pamp.	12.3	31.7	19.0	59.7	7.4	71.2	27.5	57.7	48.4
	South	28.1	17.3	35.1	5.0	76.2	6.3	11.3	15.0	18.5
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Input Int.	Cuyo	4.9	4.4	6.0	5.8	12.0	4.2	3.9	3.7	4.5
	NE	4.8	3.7	3.3	2.5	0.3	3.9	3.5	3.5	9.0
	NW	7.0	6.3	6.3	5.7	2.9	5.2	8.6	5.0	6.3
	Pamp.	77.6	81.5	78.3	82.4	11.3	82.5	80.6	83.7	68.1
	South	5.6	4.1	6.0	3.7	73.6	4.2	3.3	4.0	12.2
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
V.A.	Cuyo	6.4	5.4	7.0	7.5	13.3	4.4	3.9	4.1	4.5
	NE	7.0	5.4	4.9	2.8	0.3	4.4	5.4	3.9	9.7
	NW	10.7	9.0	7.7	5.3	4.2	5.3	12.7	5.6	7.8
	Pamp.	66.0	74.5	70.0	80.5	10.6	81.4	73.5	81.0	62.6
	South	9.8	5.8	10.4	4.0	71.6	4.4	4.4	5.4	15.4
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
G.O.	Cuyo	6.4	5.4	7.2	8.5	12.8	4.5	4.1	4.2	4.5
	NE	7.1	5.3	5.0	2.5	0.3	4.5	5.4	4.0	10.2
	NW	10.7	8.9	7.8	5.5	3.9	5.4	12.8	5.7	7.7
	Pamp.	66.0	74.6	69.5	79.5	10.2	81.2	73.4	80.7	63.0
	South	9.8	5.9	10.5	3.9	72.8	4.4	4.4	5.4	14.5
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Author's estimations.

Table 5 shows the relevance for each of the region of the external inputs of the different sectors. In the case of Cuyo, the main sector demanding inputs outside the region is the Industry (62%) followed by Trade & Transport (13%). In contrast, the for the NE region the main sector is Trade & Transport (31.3%) that is also an important sector for the NW region (with 29.2% of the total external inputs). Both, NE and NW regions have an important external inputs demand for Public Adm., Health and Education sector. Whereas the Pampeana region has an important demand from the Industry and the South region from the Mining & Energy sector. In the case of the internal inputs most of the regions have an important demand of Industrial inputs. The NW region has

Primary sector as a relevant one. Similarly, the South region has a relevant internal input demand from the Mining & Energy sector. It is interesting to note that Trade & Transport is the main sector by V.A. in most of the regions together with the Public Adm., Health and Education sector, including at the more industrialized Pampeana region. The Mining & Energy sector is relevant for the South region total V.A.

Table 5: Economic Sector participation by region (in percentage)

		Public Adm.	Trade & Transp.	Const.	Ind.	Min. & Energ.	Other Serv.	Prim.	Finan. Serv.	Public Util.	
Input Ext.	Cuyo	7.0	13.4	3.8	62.1	5.8	0.9	2.3	3.4	1.3	100.0
	NE	17.1	31.3	6.1	15.6	0.2	2.1	12.4	6.1	9.1	100.0
	NW	15.2	29.2	4.3	22.3	2.4	1.0	16.6	5.1	3.9	100.0
	Pamp.	2.4	13.6	1.7	58.4	1.4	3.5	4.2	9.2	5.6	100.0
	South	13.1	17.7	7.7	11.7	34.1	0.8	4.1	5.7	5.1	100.0
Input Int.	Cuyo	8.1	22.2	5.4	39.5	5.4	2.4	6.8	7.1	3.0	100.0
	NE	11.7	27.7	4.4	24.8	0.2	3.3	9.1	9.9	9.0	100.0
	NW	9.5	26.2	4.7	32.2	1.1	2.4	12.4	7.9	3.6	100.0
	Pamp.	8.1	26.2	4.5	35.9	0.3	3.0	8.9	10.2	3.0	100.0
	South	7.8	17.6	4.6	21.3	28.3	2.0	4.9	6.5	7.1	100.0
V.A.	Cuyo	21.2	23.7	5.3	20.1	10.4	2.8	4.1	10.7	1.6	100.0
	NE	29.1	29.4	4.6	9.2	0.3	3.4	7.1	12.6	4.3	100.0
	NW	26.8	29.9	4.4	10.7	2.5	2.5	10.1	11.0	2.1	100.0
	Pamp.	18.5	27.7	4.5	18.2	0.7	4.3	6.5	17.7	1.9	100.0
	South	20.4	16.0	4.9	6.7	35.0	1.7	2.9	8.8	3.5	100.0
G.O.	Cuyo	14.2	20.8	5.0	35.3	7.9	2.3	4.6	7.9	2.1	100.0
	NE	22.1	28.9	4.8	14.9	0.2	3.2	8.6	10.6	6.7	100.0
	NW	19.7	28.4	4.5	19.2	2.0	2.3	11.9	9.0	3.0	100.0
	Pamp.	13.0	25.6	4.3	29.4	0.6	3.6	7.3	13.6	2.6	100.0
	South	15.8	16.5	5.3	11.9	32.8	1.6	3.6	7.5	4.9	100.0

Source: Author's estimations.

The following Table 6 and Table 7 summarize the regional participation for the main industrial sectors. As can be seen, the Cuyo region has a relevant participation as the total external inputs for the Food & Beb. sector. The NE region has an important participation in the external inputs for the Wood & Paper sector. The NW region in Other Machinery as well as Textile & Shoes. The South region has an important participation in the total external inputs for the Machinery sector. The Pampeana region dominates in all the sectors (except the mentioned Food & Beverages). Also, the largest participation in internal inputs is for the Pampeana region. The only relative exception is given by the Refinery Services sector. In addition, the Pampeana region dominates the V.A. in all the industrial sectors, explaining more than 70% in all of them.

Table 6: Regional participation by industrial sectors (in percentage)

		Food & Beb.	Autom. & Parts	Wood & Paper	Mach.	Metal.	Min. no Metal.	Other Mach.	Chem. & Plast.	Ref. Serv.	Text. Shoes
Input Ext.	Cuyo	48.3	1.2	16.9	5.3	7.4	20.0	13.7	8.5	15.1	4.6
	NE	3.3	0.1	34.5	0.4	2.3	12.6	21.8	1.6	0.3	7.4
	NW	8.2	0.3	12.0	1.2	11.8	7.2	31.2	2.8	8.7	13.7
	Pamp.	36.8	97.9	31.5	44.8	54.9	56.0	24.6	84.8	75.6	69.6
	South	3.5	0.5	5.2	48.3	23.6	4.1	8.8	2.2	0.2	4.7
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Input Int.	Cuyo	5.6	3.6	5.1	3.7	3.0	8.2	4.4	4.8	20.7	2.6
	NE	3.2	0.2	7.0	0.4	0.4	4.3	3.2	0.5	0.2	2.9
	NW	7.7	1.3	4.7	1.7	5.0	6.6	5.7	1.6	4.6	6.6
	Pamp.	80.2	93.5	81.6	87.1	85.2	77.1	83.0	92.1	63.0	86.3
	South	3.2	1.4	1.5	7.2	6.5	3.9	3.8	1.0	11.5	1.6
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
V.A.	Cuyo	11.8	3.0	6.6	3.7	3.4	9.9	5.4	5.1	16.8	2.8
	NE	3.2	0.3	9.9	0.5	0.7	5.7	5.6	0.7	0.4	3.4
	NW	7.6	1.0	5.6	1.5	5.7	6.6	9.2	1.8	7.1	7.3
	Pamp.	74.3	94.7	75.8	81.4	82.0	73.8	75.5	91.2	72.1	84.6
	South	3.2	1.1	2.1	12.8	8.2	4.0	4.3	1.2	3.6	2.0
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
G.O.	Cuyo	11.9	3.0	6.7	3.8	3.5	10.2	5.5	5.2	17.0	2.8
	NE	3.2	0.2	10.3	0.4	0.7	5.8	5.7	0.7	0.3	3.5
	NW	7.7	1.0	5.6	1.6	5.8	6.7	9.2	1.8	7.2	7.4
	Pamp.	73.9	94.6	75.3	81.0	81.6	73.4	75.2	91.0	71.5	84.3
	South	3.2	1.1	2.1	13.2	8.5	4.0	4.4	1.2	4.0	2.0
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Author's estimations.

Table 7 summarizes the regional participation by industrial sectors. It can be noted that most of the external inputs of Cuyo region are demanded by the Food & Beverage sector. In the case of the NE region is the Wood & Paper sector. The Refinery Serv. sector is relevant for the NW and Cuyo region. The machinery sector is the one with more external input demand for the Patagonian region. In the case of the Pampeana region the most important external input demand is for the Refinery Serv. sector. In the case of the internal inputs, the Food & Beverage sector seems to be the more relevant for all the regions. Whereas Wood & Paper sector is relevant for the NE, Metal is relevant for the South region and Chem. & Plastic for the Pampeana region.

In V.A. the Food & Beverage sector is relevant for all the regions but more relevant for Cuyo. Wood & Paper sector is relevant for the NE as well as Food & Beverage and Min. no metal sectors. In the case of NW, the Food & Beverage sector as well as Metallic sector. In the case of Pampeana (the more harmonic V.A. through all the industrial sectors) the Food & Beverage as well as the Chemical & Plastic and the Metallic sector. In the case of the South, the two more relevant industrial sectors include Food & Beverage, Machinery and Metallic.

Table 7: Industrial Sector participation by region (in percentage)

		Food & Beb.	Autom. & Parts	Wood & Paper	Mach.	Metal.	Min. no Metal.	Other Mach.	Chem. & Plast.	Ref. Serv.	Text. Shoes
Input Ext.	Cuyo	65.8	0.2	2.3	0.8	1.5	2.2	0.6	3.8	22.3	0.4
	NE	32.2	0.1	33.2	0.5	3.4	10.1	7.4	5.2	3.0	5.0
	NW	33.9	0.1	4.8	0.6	7.3	2.4	4.4	3.8	38.8	3.8
	Pamp.	20.2	5.0	1.7	2.9	4.5	2.5	0.5	15.2	45.0	2.6
	South	22.7	0.3	3.3	37.6	23.3	2.2	2.0	4.8	1.7	2.1
Input Int.	Cuyo	49.0	1.9	4.8	3.6	4.3	4.1	1.4	10.9	18.2	1.8
	NE	66.7	0.3	15.6	0.9	1.3	5.1	2.5	2.7	0.5	4.6
	NW	68.2	0.7	4.5	1.7	7.4	3.4	1.9	3.6	4.2	4.5
	Pamp.	49.2	3.4	5.4	6.0	8.7	2.7	1.9	14.8	3.9	4.0
	South	44.5	1.1	2.3	11.2	14.7	3.0	1.9	3.7	15.9	1.6
V.A.	Cuyo	47.5	2.1	7.5	3.7	5.6	6.4	2.7	12.1	10.4	2.0
	NE	35.3	0.5	30.7	1.3	3.0	10.0	7.4	4.5	0.7	6.6
	NW	42.9	1.0	9.0	2.1	13.3	6.0	6.3	6.0	6.2	7.2
	Pamp.	27.8	6.3	8.0	7.5	12.6	4.4	3.4	20.1	4.2	5.6
	South	23.8	1.5	4.4	23.9	25.3	4.9	3.9	5.5	4.2	2.6
G.O.	Cuyo	51.9	2.3	4.8	3.0	3.8	3.9	1.5	9.9	17.4	1.4
	NW	51.2	1.2	6.2	1.9	9.7	3.9	3.8	5.2	11.3	5.6
	Pamp.	34.3	7.7	5.8	6.8	9.5	3.0	2.2	18.4	7.8	4.4
	South	30.4	1.9	3.2	22.5	20.0	3.3	2.6	5.1	8.8	2.1

Source: Author's estimations.

4 Multi-regional Demand and Value Added adjusted Multipliers

4.1 Shocks impacts by region

As mentioned before, one of the possible uses of the MRIO table is to estimate impacts at regional level. A simple application of the impacts of regional shocks can be analyzed following the developments by Miller and Blair (2009). An interesting aspect of the MRIO is that the Leontieff inverse coefficients convey the total impact from a demand change at the origin region r including all the changes in the output of all the different sectors providing inputs and final products to the region r, in all the different regions desegregated in the MRIO. The shocks are transmitted through the regions and economic sectors. Actually, in a MRIO model, an increase in the demand may not only be felt in a given region as can be distributed in the multi regional model across the supplying regions of the particular good (depending on the regional components of the sub-matrices representing intra and inter-regional flows of goods and services through the regions). Also, sector and value added adjusted multipliers can be calculated, in a similar way as in the national IO case.

Table 8 and Table 9 summarize the aggregated Leontieff coefficients for the direct and indirect impacts originated in each of the regions indicating the impact in all other regions. In fact, the Table 8 summarizes the direct and indirect impact of a unitary increase in the demand of the origin region over the other regions aggregated by all the sectors. It can be noted that the main effect of the shock is always in the own region. The main direct impact (shown by the diagonal values) is in the case of the Pampeana region. Whereas the lower impact is in the case of the South region. It is interesting to note that the Cuyo, Northwest and Northeast direct impact are similar. However, the Cuyo region holds the larger total direct and indirect impact, 1.77. It is interesting to see that the regional interactions are not necessarily symmetric.

Table 8: Leontieff inverse coefficients aggregated by Region

	Origin region				
	Cuyo (1)	Northeast (2)	Northwest (3)	Pampeana (4)	South (5)
Cuyo (1)	1.36	0.02	0.01	0.02	0.01
Northeast (2)	0.02	1.33	0.03	0.01	0.00
Northwest (3)	0.03	0.04	1.36	0.02	0.01
Pampeana (4)	0.30	0.24	0.24	1.59	0, 29
South (5)	0.07	0.02	0.04	0.05	1.30
Total	1.77	1.65	1.67	1.68	1.61

Source: Author's estimations.

Table 9 indicate the direct and indirect impact as a percentage of the total impact by region, net of the unitary shock. Again, the diagonal values are the largest one. However, the Pampeana region stands out as the main region for all the different origins. In particular, a Pampeana region shock generates a multiplier effect in the own region explaining 86.10% of the total effect. The impact of a Pampeana region is actually important in the other regions, but lower than the direct effect in the own region. A shock in all the other regions have an important impact on the Pampeana region (ranging from 35% to 47%) showing the relevance of the most prosperous region. Again, in the case of the South region, the sum of the own regional multiplier and the one corresponding to Pampeana explain 96% of the total impact due to a shock with origin in the South region. The impact at Cuyo is 2% of the multiplier whereas the impact over NW and NE are lower than 2% of the total multiplier. In contrast, a shock originated at NW region generate a multiplier impact of equivalent to 3% of the total multiplier in the South region and 6% for the NE region. A shock at the Pampeana region generates a direct and indirect effect of 7% of the total effect at the South. Beyond the regional heterogeneity between the Pampeana region and the rest of the country, the NW, NE and Cuyo regions hold an asymmetric relationship with the distant South. The differences are explained by the combination of distance and sector specialization as shown in the Figures below.

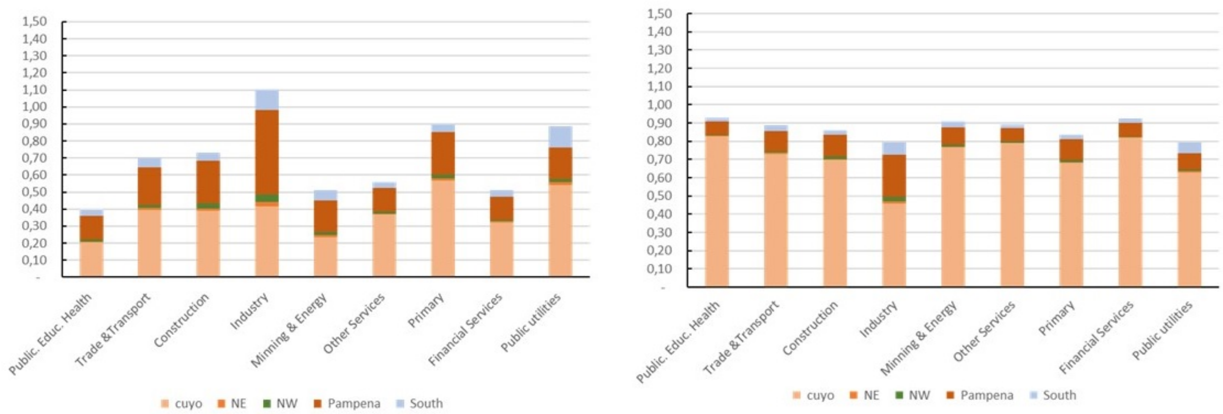
Table 9: Direct & Indirect Impact of by (origin) region (percentage)

	Origin region				
	Cuyo (1)	Northeast (2)	Northwest (3)	Pampeana (4)	South (5)
Cuyo (1)	46.20	2.70	1.80	2.60	1.90
Northeast (2)	2.00	50.90	4.40	1.60	0.60
Northwest (3)	3.60	6.30	52.80	2.80	1.70
Pampeana (4)	38.50	37.20	34.90	86.10	47.10
South (5)	9.70	2.90	6.10	6.90	48.60
Total	100.0	100.0	100.0	100.0	100.0

Source: Author's estimations.

The multipliers can be analyzed by economic sector as we can see in the following Figures. The Figure 1 summarizes the multiplier direct and indirect impact of a 1% increase at Cuyo demand (and V.A. adjusted). As can be noted, the main impact is given at industrial sector, with the largest mutiplier at Pampeana region (almost 50% of the direct and indirect impact is through this region multiplier). In fact, the multiplier is larger than the own multiplier for that particular sector. In contrast, the Primary and the Public Utility sectors are also relevant but with a largest impact at the own region (more than 60% of the total multiplier effect of each sector). As analyzed before in Table 8 and Table 9 the multiplier effect increases (by 1.53) when weighted by the region value added. However, the Industry, Primary and Public Utilities sectors multipliers decreased. The Public Adm., Education & Health sector presents the largest change in the V.A. adjusted multiplier.

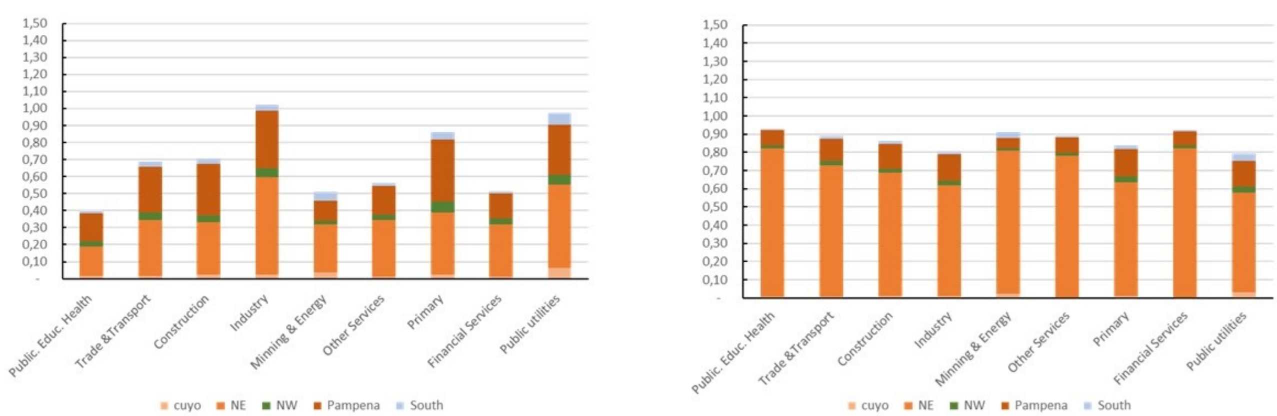
Figure 1: Shock at Cuyo (origin) Region - Demand (LHS) and VA adjusted (RHS)



Source: Author's estimations.

The Figure 2 summarizes the multiplier direct and indirect impact of a 1% Demand shock at Northeast region. As highlighted in Table 8 and Table 9, the global result is that 51% of the multiplier impact is reflected in the same region (81% in the value added weighted case) and the multiplier increases by 1.61. In this case, the Industry has the largest multiplier but, as in the case of Public Utilities and Primary sectors the multiplier decreases when the V.A. is incorporated. As in most of the analyzed regions the Pampeana region is a key provider for the Primary and Industrial sectors (approximately 35% of the direct and indirect impact is coming from this particular region).

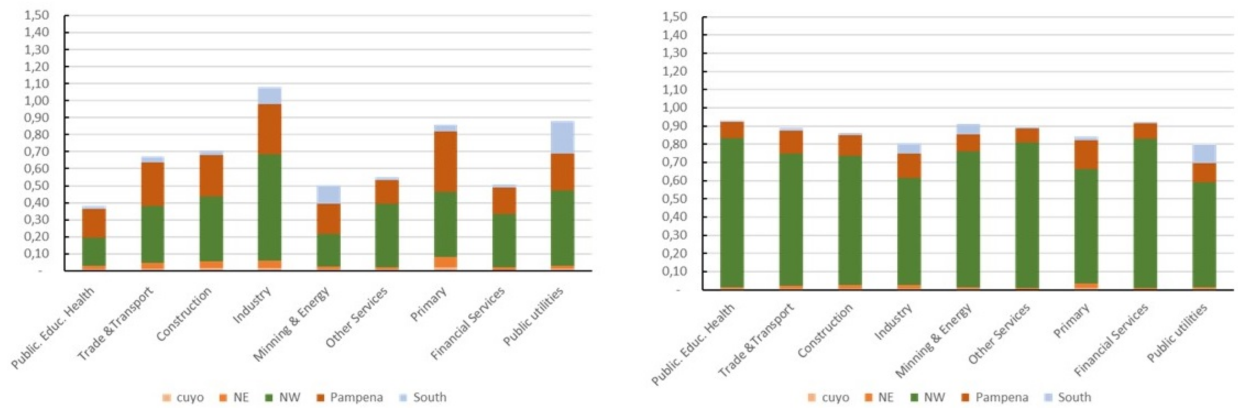
Figure 2: Northeast



Source: Author's estimations.

Again, in the case of the Northwest region (Figure 3), the main multiplier impact is at the Industry, where the own region indirect and direct impact is 62% and 75% (VA adjusted). as in the previous cases, the impact is reduced when the own region V.A. is considered. In the case of the Primary sector the Pampeana region is a key provider with a multiplier similar to the own region one. As in the case of the NE region, the NW overall indirect and direct impact of the own region explain 52% and 82% (V.A. adjusted) of the overall multiplier.

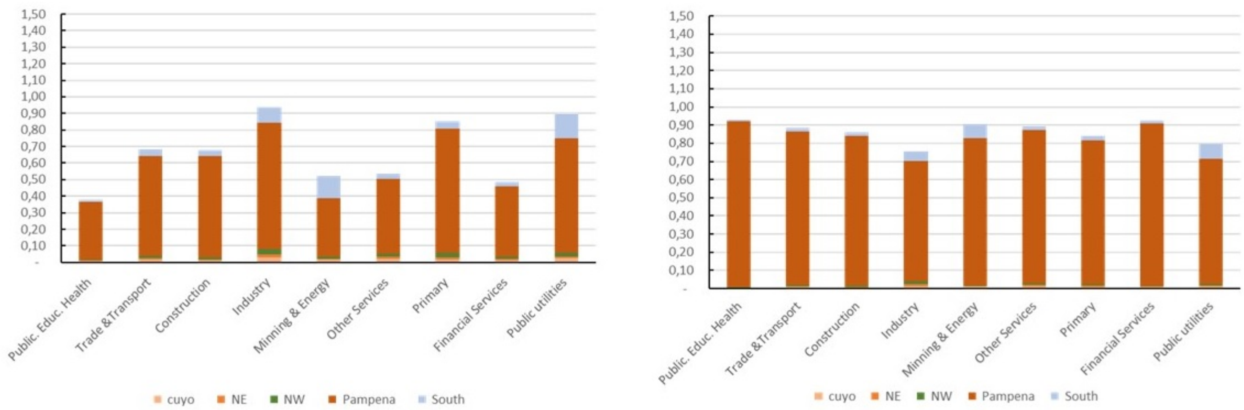
Figure 3: Northwest



Source: Author's estimations.

As already mentioned in Table 8 and Table 9, the Pampeana region has a total multiplier impact that is explained in a 84% and 93 % (V.A. adjusted) by its own direct and indirect multiplier as one would expect considering that it is the richest region in the country. As can be seen in Figure 4, the Mining & Energy sector present the lowest multiplier effect, contrasting with the Industry, Primary and the Public Utility sectors. In addition, it is interesting to note that the V.A. adjusted multiplier for the Industry sector is lower than the non adjusted as in the previous regions case.

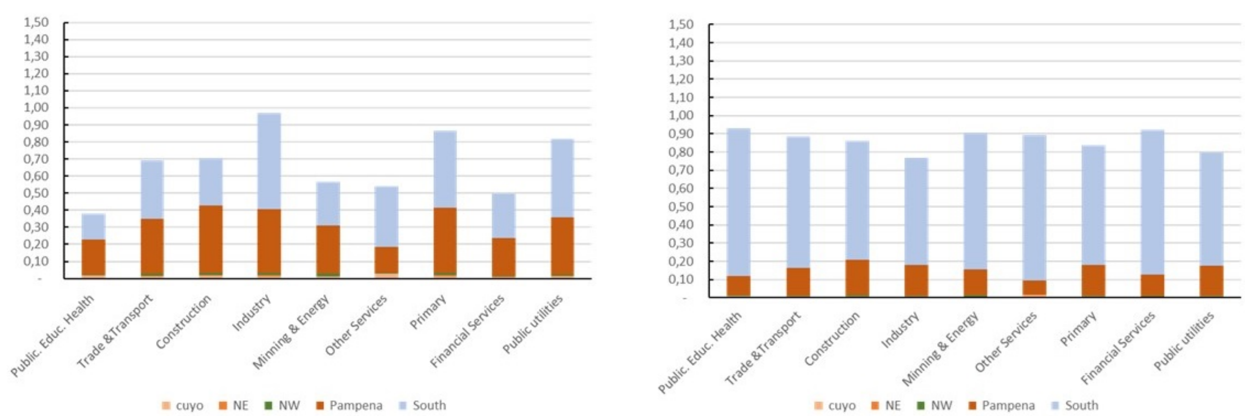
Figure 4: Pampeana



Source: Author's estimations.

Finally, the South region, shown in Figure 5, presents a multiplier profile showing only positive changes in V.A. adjusted multipliers. Also, the Pampeana region multipliers are the largest one for all the sectors, even in the V.A. adjusted case. In fact, the own region plus Pampeana region multipliers explain more than 98% of the total multiplier effect in each of the considered regions. The multiplier impact of a shock in the South region over the northern regions and Cuyo are below 5% and 2% when adjusted by value added.

Figure 5: South



Source: Author's estimations.

5 Conclusions

The Multi-Regional Input-Output (MRIO) Table has become an indispensable instrument for regional and macroeconomic policy analysis, widely leveraged to investigate and simulate the effects of macroeconomic shocks on both industry and geographic dimensions. Its versatile applications include analyzing impulse responses to internal economic policies, sector-specific disturbances, and external systemic shocks across regions. The MRIO table constitutes a critical input for building sophisticated Computational General Equilibrium (CGE) models and Social Accounting Matrices (SAM), in addition to Dynamic Stochastic General Equilibrium (DSGE) Models.

The MRIO table of Argentina is built for 5 regions that aggregate the 24 provinces, and 20 economic sectors. Even with this degree of aggregation, the MRIO table reflects the asymmetry between the regions derived from the strong economic concentration in the Pampeana region and the weaker interaction with the periphery regions, including the South (Patagonian provinces), Cuyo, Northwest and Northeast regions. The table is calculated, as is usual in developing countries, under conditions of *limited information*. The primary data is based on official *make* and *use* national tables from the Argentinean Statistical Authority (INDEC). The value-added regional information from ECLAC and customized source information on inter-provincial trade for 2017 and 2021 are used to regionalize and to calculate the first (to our knowledge) MRIO table for Argentina.

To capture the interconnection and the distinctive features of the regions and economic sectors of Argentina we estimate the usual I-O multipliers. The results validate the asymmetric economic structure found with different approaches in previous research projects underscoring the high concentration in the provinces of the Pampeana region in gross output, value added and regional internal inputs. The concentration is less important for the extra regional inputs trade that accounts for only 18% of total input inter-regional trade. In addition, the analysis of multipliers allows us to detect some relevant links in the peripheral regions reflecting the interaction of spatial and sector specialization. These findings provide insights for future applications and underscore the importance of advancing in more in-depth input-output modeling and analysis of production, consumption, financial and trade linkages between regions and sectors in Argentina.

By presenting this novel tool with regional desegregation for Argentina the present research provides a relevant contribution to the regional economic literature. The next steps in this challenging agenda includes the use of spatial econometrics techniques to evaluate the relevance of the inter-regional financial and trade flows between regions and sectors as well as a further desegregation of the MRIO table at provincial level. Both research lines will provide insightful inputs for the development of more sophisticated technical tool adept at analyzing and simulating the inter-regional impacts of various macroeconomic, monetary, financial, and regulatory policies at Argentina.

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Appendix

Figure A: Regions of Argentina